Multipoint Arc Initiation

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The idea of this project is to use an array of arcs, rather than exploding bridge wires or exploding foil initiators, to detonate high explosives (HE). The array of arcs creates extreme temperatures and pressures, which should ignite HE using lower energy than conventional means.

For this year, the feasibility of this concept has been demonstrated by the design of a multipoint system with jitter less than 2 ns. Single arc initiation of numerous types of secondary HE was demonstrated prior to the start of this project.

Project Goals

The goal of this project is to construct a multipoint arc initiator with low point-to-point jitter.

Relevance to LLNL Mission

Initiation of HE using lower energies has relevance to numerous DoD and DOE applications. Most important, lowering the energy required for reliable detonation could enable less sensitive HE to be ignited using a given energy. Initiating less sensitive HE has universal relevance to safety improvement.

FY2004 Accomplishments and Results

A fireset has been built for the initial laboratory testing of multipoint initiators. The fireset consists of a capacitor with a bleed resistor, a spark-gap switch with a trigger board, and a current viewing resistor. The current generation fireset is capable of being charged to 12 kV. The charging voltage must be supplied by an external power supply. The capacitor's voltage can be monitored with the fireset's voltage monitor output. The fireset is triggered using a 40-V signal provided by a Stanford delay generator.

A variety of capacitors have been designed and built with capacitances ranging from 300 to 2000 pF. These different capacitors will be used to minimize the total circuit energy required for initiation.

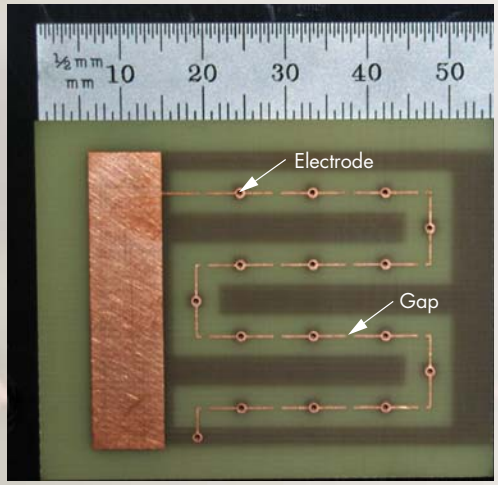

Figure 1. Initiator board.

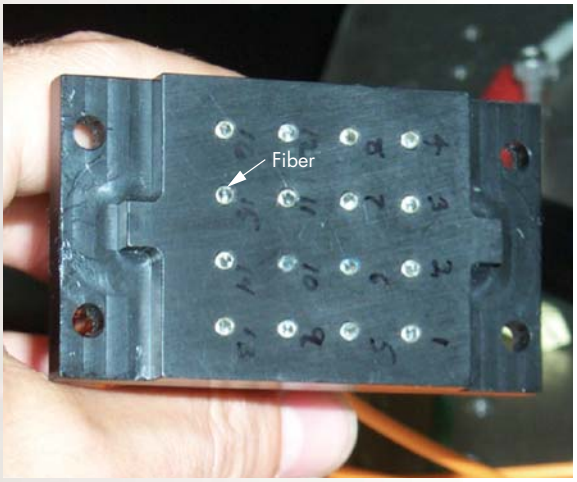

Figure 2. Fiber optics.

Initiator boards have been built using printed circuit board technology (Fig. 1). In the first series of tests, sixteen-point boards with gap distances of 30, 50, 70 and 90 mils are being studied.

Each electrode is connected to ground through a resistor. The optimal resistance value is under investigation. If the resistance is too low, the capacitor's energy will be depleted before the entire sequence of gaps breakdown. If the resistance is too large, the arc will not be sustained and, potentially, there will be arcing over the resistor to ground.

A fixture has been constructed to house the initiator boards and hold the fiber optics, which view the gaps.

Arc light is transmitted through the fiber optics shown in Fig. 2, and it is imaged onto a streak camera (Fig. 3). The streak camera records this light as well as a timing signal. With the first set of experiments, we have achieved an eight-point system with less than 2.3 ns of jitter. The jitter may be lower than this, but we are limited in accuracy of the jitter measurement by the camera's sweep speed.

Figure 4 shows the streak record for the eight-point system.

FY2005 Proposed Work

We will increase the number of simultaneous arcs. We would like to demonstrate that less sensitive HE can be ignited using this system. After such demonstration, we will minimize the energy required for ignition of a given high explosive and determine how insensitive an explosive we can detonate using the multiarc concept.

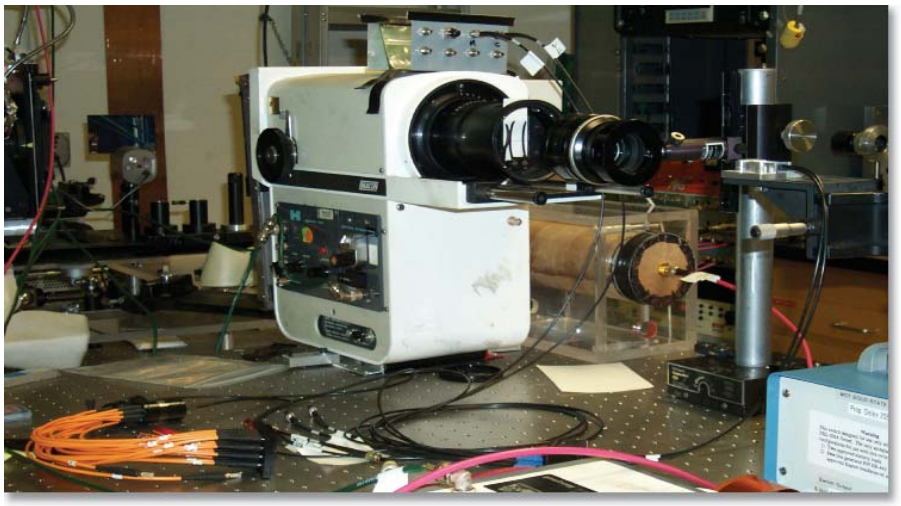

Figure 3. Streak camera and fiber.

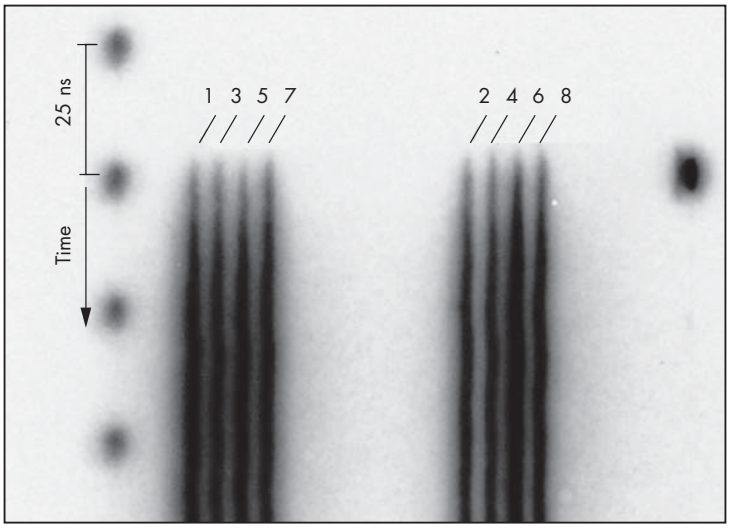

Figure 4. Streak record. The spots on the left are laser pulses spaced at 25 ns; the arrow on the left gives the direction of time. The arcs begin in the faint top region. Eight streaks show the timing for the eight arcs.